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**CONFIDENTIAL**  
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Docket No. 3099(S)

**IN THE UNITED STATES PATENT & TRADEMARK OFFICE**

Applicants: Martin Stevens SMITH, ET AL  
Serial No.: **702463**  
Filed: May 2, 1991  
For: SEA SURFACE ANTENNA

**CLAIM TO PRIORITY**

BOX SN  
Hon. Commissioner of Patents & Trademarks  
Washington, D. C. 20231

Sir:

Under the provisions of 35 USC 119 and 37 CFR §1.55, applicants hereby claim the right of priority based on United Kingdom Patent Application No. 9009871.6 filed in Great Britain on May 2, 1990.

A certified copy of applicants' priority document is submitted herewith.

Respectfully submitted,

KERKAM, STOWELL,  
KONDRACKI & CLARKE, P.C.

  
Dennis P. Clarke  
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THE PATENT OFFICE  
STATE HOUSE  
66-71 HIGH HOLBORN  
LONDON WC1R 4TP

I, the undersigned, being an officer duly authorised in accordance with Section 62(3) of the Patents and Designs Act 1907, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of documents as originally filed in connection with the patent application identified therein.

I further certify that pursuant to Section 22(1) of the Patents Act, 1977, the Comptroller has ordered prohibition of publication of the said specification.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents, has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or the inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Witness my hand this 22nd day of April 19 91

CERTIFIED COPY OF  
PRIORITY DOCUMENT

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(Rules 16, 19)

**The Comptroller  
The Patent Office**

- 2 MAY 1964

-4MAY 7904001A4491 PAT 1 77 UC 15.00

# REQUEST FOR GRANT OF A PATENT

9009871.6

**THE GRANT OF A PATENT IS REQUESTED BY THE UNDERSIGNED ON THE BASIS OF THE PRESENT APPLICATION**

**Applicant's or Agent's reference (Please insert if available)**

M S Smith 5-1

11 Title of invention SEA SURFACE ANTENNA

### III Applicant or Applicants (See note 2)

Name (First or only applicant) STC PLC

Country Great Britain State ADP Code No 03982287001

**Address** 1B Portland Place, London, WIN 3AA

Name (of second applicant, if more than one).....

..... **Country** ..... **State** .....

Address .....

IV Inventor (see note 3)

(X)The application is a/an HE  
sole/joint inventor(s)XXXXXXXX

of

(b) A statement on Patents Form No 7/77 is/will be furnished

V Name of Agent (if any) (See note 4)

~~J. P. W. Ryan~~

ADP CODE NO

VI Address for Service (See note 5)

STC Patents  
West Road, Harlow, Essex, CM20 2SH

VII Declaration of Priority (See note 6)

Country

**Filing date**

**File number**

THE PATENT OFFICE  
ROOM 331  
- 2 MAY 1990  
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VIII The Application claims an earlier date under Section 8(3), 12(6), 15(4), or 37(4) (See note 7)

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**A** The application contains the following number of sheet(s) **B** The application as filed is accompanied by:-

1	Request	ONE	Sheet(s)	1	Priority document	NO
2	Description	four	Sheet(s)		Translation of priority document	NO
3	Claim(s)	ONE	Sheet(s)	3	Request for Search	YES
4	Drawing(s)	ONE	Sheet(s)	4	Statement of Inventorship and Right to Grant	YES
5	Abstract	ONE	Sheet(s)			

X It is suggested that Figure No.....of the drawings (if any) should accompany the abstract when published.

XI Signature (See note 8) *J P W Ryan* J P W Ryan - Agent for the Applicant.

**NOTES:**

1. This form, when completed, should be brought or sent to the Patent Office together with the prescribed fee and two copies of the description of the invention, and of any drawings.
2. Enter the name and address of each applicant. Names of individuals should be indicated in full and the surname or family name should be underlined. The names of all partners in a firm must be given in full. Bodies corporate should be designated by their corporate name and the country of incorporation and, where appropriate, the state of incorporation within that country should be entered where provided. Full corporate details, eg a "corporation organised and existing under the laws of the State of Delaware, United States of America", trading styles, eg "trading as xyz company", nationality, and former names, eg "formerly (known as) ABC Ltd" are *not* required and should *not* be given. Also enter applicant(s) ADP Code No.(if known).
3. Where the applicant or applicants is/are the sole inventor or the joint inventors, the declaration (a) to that effect at IV should be completed, and the alternative statement (b) deleted. If, however, this is not the case the declaration (a) should be struck out and a statement will then be required to be filed upon Patent Form No 7/77.
4. If the applicant has appointed an agent to act on his behalf, the agent's name and the address of his place of business should be indicated in the spaces available at V and VI. Also insert agent's ADP Code No. (if known) in the box provided.
5. An address for service in the United Kingdom to which all documents may be sent must be stated at VI. It is recommended that a telephone number be provided if an agent is not appointed.
6. The declaration of priority at VII should state the date of the previous filing and the country in which it was made and indicate the file number, if available.
7. When an application is made by virtue of section 8(3), 12(6), 15(4) the appropriate section should be identified at VIII and the number of the earlier application or any patent granted thereon identified.
8. Attention is directed to rules 90 and 106 of the Patent Rules 1982.
9. Attention of applicants is drawn to the desirability of avoiding publication of inventions relating to any article, material or device intended or adapted for use in war (Official Secrets Acts, 1911 and 1920). In addition after an application for a patent has been filed at the Patent Office the comptroller will consider whether publication or communication of the invention should be prohibited or restricted under section 22 of the Act and will inform the applicant if such prohibition is necessary.
10. Applicants resident in the United Kingdom are also reminded that, under the provisions of section 23 applications may not be filed abroad without written permission or unless an application has been filed not less than six weeks previously in the United Kingdom for a patent for the same invention and no direction prohibiting publication or communication has been given or any such direction has been received.

- 2 MAY 1978

(Rules 15, 82)

The Comptroller  
The Patent Office

## STATEMENT OF INVENTORSHIP AND OF RIGHT TO THE GRANT OF A PATENT

I Application No.

9009871.6

II Title

SEA SURFACE ANTENNA

III I/We ... STC PLC, a British Company of 1B Portland Place, London WIN 3AA

the applicant(s) in respect of the above mentioned application for a patent declare as follows:-

i) I/We believe the person(s) whose name(s) and address(es) are stated on the reverse side of this form (and supplementary sheet if necessary) is/are the inventor(s) of the invention in respect of which the above mentioned application is made;

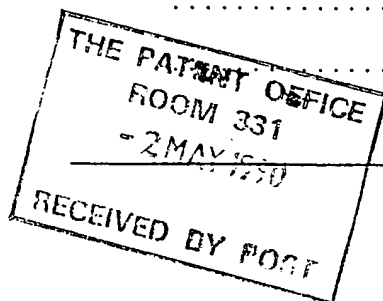
ii) The derivation of my/our right to be granted a patent upon the said application is as follows:

At the time of the making of the invention we were entitled to the whole of the property in it in the United Kingdom by virtue of contract of employment.

iii) I/We consent to the publication of the details contained herein to each of the inventors named on the reverse side of this form.

IV Signature  
(see Note 3)

J P W Ryan - Agent for the Applicant



PLEASE SEE OVERLEAF

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Dr Martin Stevens Smith  
8 Chuzzlewit Drive  
Chelmsford  
Essex  
CM1 4XQ

- 1 The name(s) and address(es) of the inventor(s) are to be entered in the spaces provided alongside.
- 2 Where more than 3 inventors are to be named, the names of the 4th and any further inventors should be given on the reverse side of an additional blank copy of Patents Form No. 7/77 and attached to this form.
- 3 Attention is directed to rules 90 and 106 of the Patents Rules 1982.
- 4 The surnames or family names of individuals should be underlined.

David Neil Adams  
24B Tredegar Road  
Bow  
London  
E3 2EH

Sea Surface Antenna

This invention relates to a sea surface antenna which can be towed behind a marine craft for radio communication purposes.

A so-called buoyant antenna is disclosed in the paper "A Slender Resonator - Slot Antenna" by J.C. Lee, IEE International Conference on Antennas and Propagation, Conf. Publ. No. 195, pp 442-446, 1981. Essentially the antenna disclosed comprises a slot formed by the edge opening in a roll-resonator of copper clad plastic dielectric, approximately  $1/2$  free-space wavelength long. The slot is short circuited at the two ends, and the antenna is fed by a coaxial line the inner and outer conductors of which are soldered to respective sides of the slot. A modified antenna is disclosed in "UHF Buoyant Antenna" by M.S. Smith et al, IEE ICAP 87, pp 1.273-1.276, 1987. The modified antenna augments the "per unit length" capacitance by discrete capacitors connected across the slot, the length of the antenna being approximately equal to  $\lambda/2$ , where  $\lambda$  is the free space wavelength at the operating frequency of the antenna. The practical design disclosed in Fig. 1(b) of the paper comprises a cylindrical tube of metallic material on a dielectric former having a longitudinal slot which is shorted at each end and coupled to a coaxial feed at its centre, the slot being bridged by two capacitances respectively positioned approximately

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midway between the centre feed and the shorted ends. The antenna length is approximately  $\lambda/2$  and operates in a weakly evanescent mode. However, there are applications in which a buoyant antenna is required which is limited to smaller dimensions imposed by physical constraints in its operating environment.

According to the present invention there is provided a sea surface antenna comprising a tube of metallic material, the tube having a substantially longitudinal slot coupled at or near its midpoint to a feed line, the slot being bridged by two pluralities of capacitances to either side of the feedpoint, each plurality being distributed along a respective part of the slot, the antenna being dimensioned so as to operate in an evanescent mode at a resonant frequency less than the cut-off frequency.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic illustration of a buoyant antenna, and

Fig. 2 is a part sectional detail of the antenna taken on the line A-A of Fig. 1.

The antenna shown in the drawings comprises a rigid cylindrical dielectric former 11 having a cladding of copper 13. A narrow longitudinal slot 15 is machined in the copper cladding. The ends 17a, 17b of the slot 15 are shorted and across the midpoint of the slot are soldered the two conductors of a coaxial cable 18 that feeds the antenna. A number of discrete capacitors 19 are mounted across the slot along its length in two equal groups in a configuration that is symmetrical about the feed point.



The exact symmetry described is not essential but is a convenient design feature.

It is important to note that the capacitors do not simply tune and match the antenna input impedance, but that they also modify the voltage distribution along the radiating slot. The feature is used to combat the evanescent nature of the antenna and to produce an effective length substantially greater than if the capacitors were not present, and hence to improve the antenna efficiency.

When a signal is applied to the centre of the slot an electric field is formed across it, spreading along its length in both directions and falling to zero at its ends. This field radiates a linearly polarised pattern with an electric field orthogonal to the line of the slot. In practice the antenna would be deployed on the sea surface which would form a lossy ground plane. The degree of loss would be angle dependent. The peak gain value of the radiation from the slot can be obtained from the distribution of the electric field along the slot.

By varying the value of the capacitors mounted across the slot the resonant frequency of the antenna is changed. The use of suitable varactor diodes with suitable variable bias means would give an antenna that could be tuned to any point within a given band. As varactors tend to have lower Q than fixed capacitors the loss will be greater. However, by using as few varactors as possible this loss can be kept to a minimum.

An experimental antenna operating at a resonant frequency of 261.0MHz in an evanescent mode has been produced. The length of the antenna is approximately 22 cm, i.e. approximately  $0.2 \lambda$ , and its

diameter is approximately 1.5 cm, i.e. approximately 0.013 \* . Due to its short physical length such an antenna has a broad hemispherical radiating pattern. The antenna has a gain of -6.0 dBi and a 3dB bandwidth of 6.1 MHz.

When two such short length evanescent mode antennas are placed in a close colinear configuration and connected electrically in parallel the observed radiation efficiency is approximately twice that of a single antenna.

Whilst one particular construction of antenna has been described, variations in the construction can be adapted. For example, the antenna can be constructed from a rigid self-supporting metal tube, not necessary cylindrical in section, without the need for a rigid dielectric former. The slot need not be a straight longitudinal slot but can be sinuous. If a hollow metal tube is employed it may be possible to locate the capacitor bridging the slot on the inside of the tube, thus allowing a smooth external profile to be achieved. Likewise the co-axial feed can be connected internally. To achieve the required buoyancy the antenna can rely on the buoyancy of the feed cable to which it is attached or, if a rigid hollow tube is used and it is enclosed in a hermetically sealing external protective covering, e.g. of plastics material, then buoyancy can be provided by gaseous content of the hollow tube.

CLAIMS

1. A sea surface antenna comprising a tube of metallic material, the tube having a substantially longitudinal slot coupled at or near its midpoint to a feed line, the slot being bridged by two pluralities of capacitances to either side of the feedpoint, each plurality being distributed along a respective part of the slot, the antenna being dimensioned so as to operate in an evanescent mode at a resonant frequency less than the cut-off frequency.
2. A sea surface antenna comprising a tube of metallic material on a dielectric former, the tube having a longitudinal slot coupled at or near its midpoint to a feed line, the slot being bridged by two pluralities of capacitances to either side of the feedpoint, each plurality being distributed along a respective part of the slot, the length of the antenna being less than  $0.25 \lambda$  and the diameter of the antenna being less than  $0.02 \lambda$ , where  $\lambda$  is the free space wavelength at the operating frequency, the antenna being dimensioned so as to operate in an evanescent mode at a resonant frequency less than the cut-off frequency.
3. An antenna according to claim 1 or 2 wherein the slot is shorted at each end.
4. An antenna according to claim 1, 2 or 3 wherein the capacitances are provided by varactor diodes, the antenna including means for applying a variable bias to the varactor diodes.
5. A sea surface antenna substantially described with reference to the accompanying drawings.
6. A sea surface antenna arrangement including two or more like antennas according to claim 1, 2, 3 or 4 placed in a colinear configuration and connected electrically in parallel.

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M.S. Smith - D.N. Adams 5-1

Figure(s) to accompany abstract

Sea Surface Antenna  
Abstract of the Disclosure

A sea surface antenna comprises a cylindrical tube of metallic material 13 on a dielectric former 11. The tube has a longitudinal slot 15 shorted at each end and coupled at its midpoint to a coaxial feed 18. The slot is bridged by two groups of capacitances 19 each group being distributed along a respective half of the slot. The length of the antenna is less than  $0.25 \lambda$  and the diameter of the antenna is less than  $0.02 \lambda$ , where  $\lambda$  is the free space wavelength at the operating frequency. The antenna is dimensioned so as to operate in an evanescent mode at a resonant frequency less than the cut-off frequency.